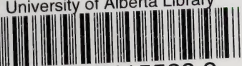


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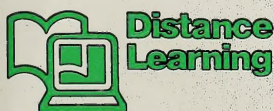


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BIOLOGY 20

Populations in Ecosystems

Module 4



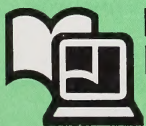
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Biology 20

Module 4

Populations in Ecosystems



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Module 4
Populations in Ecosystems
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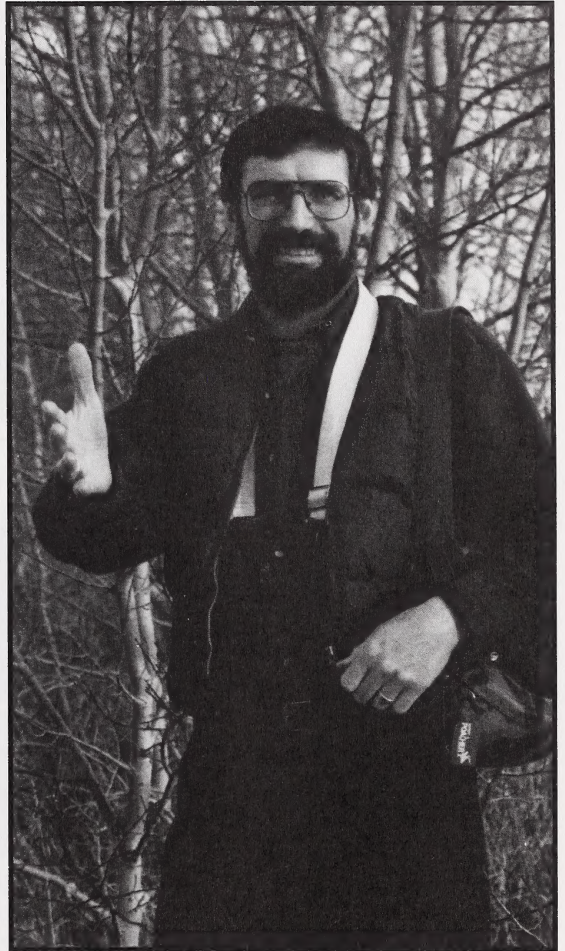
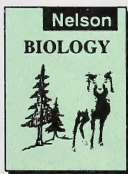
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Welcome to Module 4

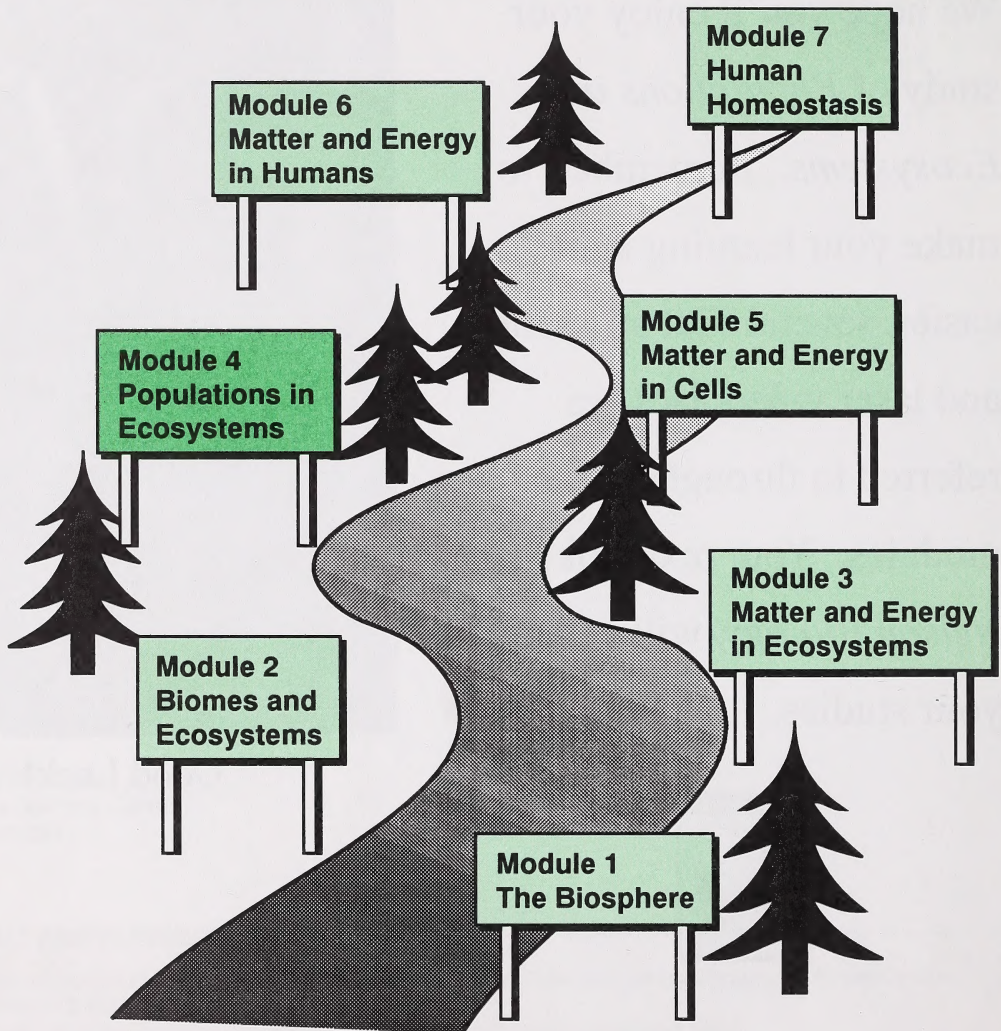
We hope you'll enjoy your study of *Populations in Ecosystems*. Remember, to make your learning a bit easier, several videocassettes and laser videodiscs are referred to throughout the modules. Your textbook, *Nelson Biology*, will enhance your studies.



Good Luck!

COURSE OVERVIEW

This course contains seven modules. The module you are working in is highlighted in a darker colour.



MODULE

4

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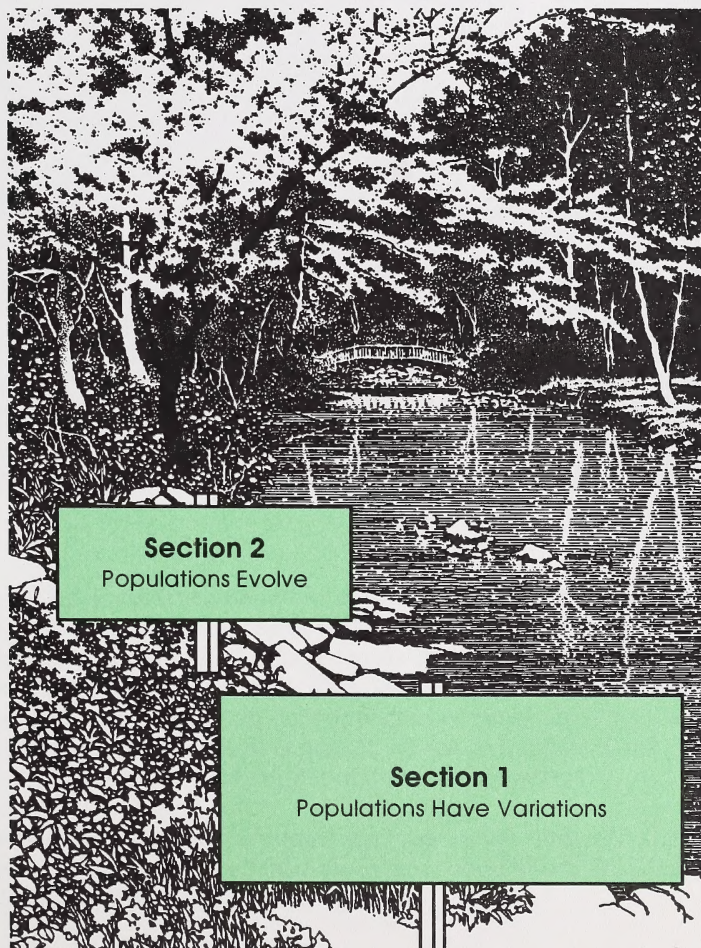
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MODULE OVERVIEW

Have you ever been lucky enough to have the “pick of the litter” from a batch of puppies or kittens? Was it a tough choice? Differences can be important, especially later when your pet grows up. Nature also chooses the pick of the litter and can certainly make tough choices. The environment, which is the biotic and abiotic factors you studied in Modules 1, 2, and 3, decides which characteristics will help an organism survive. Nature picks the best characteristics. Characteristics that survive become part of every organism in future populations.

In Module 4 you’ll study some of the characteristics of populations and some of the changes that can occur over time. All of these characteristics help living organisms process matter and energy in the biosphere.



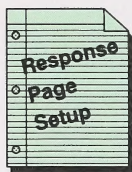
Evaluation

Your mark in this module will be determined by how well you complete the assignments at the end of each section. You must complete all assignments. In this module you are expected to complete two assignments. The mark distribution is as follows:

Section 1 Assignment:	45 marks
Section 2 Assignment:	<u>55 marks</u>
TOTAL	100 marks

When doing your assignments, work slowly and carefully. If you are having difficulties, go back and review the appropriate section.

Read all parts of your assignment carefully. Plan and do your rough work on your own paper. Revise and edit your responses; then set up your final copy for submission on your own paper. Lined looseleaf is recommended. Make sure your answers are neat and organized, with wide left margins and space for teacher comments after each assignment.



When you see this icon, ideas and details are provided to help you set up and organize your answer in a certain way.

Before submitting your responses, be sure to proofread them carefully to ensure they say what you want, that they are neat and clear, and that they are complete and missing no material.

You will be submitting **only** your **assignment response pages** for evaluation.

Populations Have Variations



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Lying on a rocky ledge above a small band of bighorn sheep, a mountain lion contemplates its next meal. The sheep don't know it but one of them is about to become part of the food chain. Populations of bighorn sheep and mountain lions have been living in Alberta for thousands of years. This has been possible because the population of sheep has always been larger than the population of mountain lions. You might think this is a perfect system. If the system is perfect, where do humans fit in? To answer this question you need to learn more about populations in ecosystems.

In this section you will learn what a population is and what similarities and differences can exist within a population. You'll also study how populations are adapted to their environment and how they grow and change.

ACTIVITY

1 Populations at a Glance

A good place to start your study of populations in ecosystems is close to home. The video *Aspects of Ecology: Populations* will show you several populations of organisms in Alberta. The video will also introduce you to several well-known Alberta ecologists. You may wish to write to these ecologists for more information.



Watch the video and answer the following questions. You may have to watch the video more than once. Read the questions first and stop the video in between questions if necessary. You may also refer to pages 576 to 587 in your text for help.

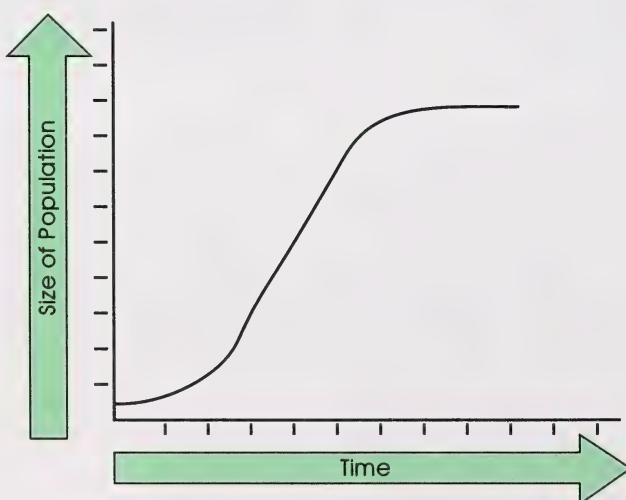
1. List the things that members of a single population have in common.
2. Write a definition of a population.
3. What environmental factors limit the number of individuals comprising a population?
4. There are two terms used to describe the patterns of dispersal of population members. Name and describe them.
5. The bison population of Elk Island is now at the environment's carrying capacity. On the following graph, draw a horizontal dotted line across the graph to show the **carrying capacity**.

carrying capacity – the population an ecosystem can indefinitely support

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

GRAPH 4.1



6. Circle the time interval on the preceding graph during which population growth was the fastest possible.
7. What factors other than the ones mentioned in question 3 control the bison (or any other) population?
8. Give three examples of how humans have intervened to benefit populations.
9. What did Thomas Malthus say about the human population?
10. The present human population of around four billion may double to eight billion in as little as thirty years. What three factors may eventually limit this growth?

If you had problems answering these questions, view the video again.

Check your answers by turning to the Appendix, Section 1: Activity 1.

You may have already noticed that members of a population are usually **similar** but they don't have to be **identical**. Variation amongst individuals in a population is quite natural. The following investigation will introduce you to some natural human variations.

Investigation: Measuring Variation

Objective

Design and perform an experiment to measure inherited variation in humans by examining specific **traits**.

Background Information

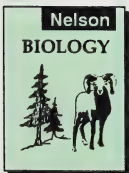
Human traits can be classified as structural, physiological (having to do with body chemistry), and behavioural. In this investigation you will deal with structural traits, such as hair colour, which can be measured by direct observation.

If you have a copy of *Biology: A Canadian Laboratory Manual*, 1987 by Ritter, Drysdale, and Coombs, check the lab on page 130 for several human traits you can use. Also check Figure 20.21 on page 482 in your text.

Procedure

Choose one or more traits of humans and a population of people with which you have contact. You will survey this population to gather data.

trait – any of an organism's inherited characteristics



Science Skills

- ☒ A. Initiating
- ☒ B. Collecting
- ☐ C. Organizing
- ☐ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

11. Write the procedure, step by step, that you will use to gather data. Use as many steps as you need.

Observation

12. Construct a table on which to collect your data. Set up the table as shown:

TRAITS	VARIATION	NUMBER/NAME OF INDIVIDUALS
--------	-----------	----------------------------

Analysis and Interpretation

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

13. Which variation of each trait was the most common one in your population? Comment on any other trends or tendencies that you have noticed. Are there any trends such as traits that tend to occur together? Describe them.

For this investigation there are no right or wrong answers unless you made observation or calculation errors. Your analysis should tell you that there can be variation within a population even though all members are of the same species. So what difference does a little variation make? This is where the ecosystem makes a difference. You'll learn more about this in Activity 2.

If you find it too difficult to examine a human population, consider visiting a pet store and looking at the variation in a population of budgie birds or guppies.

Check your answers by turning to the Appendix, Section 1: Activity 1.

ACTIVITY

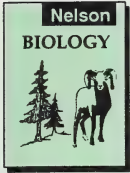
2

To Be or Not To Be

When you think of animals in the high mountains, do you think of moose and deer, or do you think of mountain goats and bighorn sheep? Hopefully you think of goats and sheep. It is likely that you'll never find moose scampering up steep cliffs. For mountain goats this is an everyday activity. All organisms seem to be adapted to where they live. Does this occur by chance?



PHOTO BY DR. FRANCIS HEIN



1. What does it mean to be adapted to where you live? Read the section entitled Importance of Adaptation on page 96 of your textbook to answer that question.

Just as individuals are adapted, so are entire populations. Every population has a definite place in its ecosystem (**habitat**). Populations, like individuals, also play a role in the food chain. A population is a significant biotic factor in any biome because of where it lives and what it does. Examine this picture and notice the different populations. Don't forget plants.



2. The organisms listed in this table are found in the ecosystem in the picture. Describe where in the forest each of them would live.

ORGANISM	HABITAT
trout	
squirrel	
ruffed grouse	
grass	

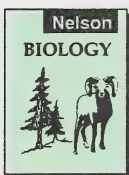
3. Now take a closer look at the ruffed grouse. What is its role in the ecosystem? Role refers to all of the activities it performs to maintain life. Name at least four things that a ruffed grouse does to stay alive.

Check your answers by turning to the Appendix, Section 1: Activity 2.

niche – the place and role of a population or individual in its ecosystem

The place and role of a population in its ecosystem is given a special name. Ecologists call it the population's **niche** or ecological niche.

A text definition appears on page 579 in your text.



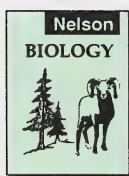
The niche of an organism is a very complex thing. For instance the grouse is an energy conveyer in the food chain. When you describe the role of any population, you can cite everything that its individuals do to maintain life and reproduce – this means that niches are very complex. Also, it implies that there are many different niches in every ecosystem.

Read the comparison of the niches of hawks and owls in the following table.

4. Where do the hawk and owl differ in their niches?

PLACE AND ROLE IN ECOSYSTEM	HAWK	GREAT GRAY OWL
Habitat	trees	trees
Nutrition	consumer	consumer
Food eaten	mice	mice
Nesting site	trees	trees
Hunting time	day	night

Notice that the niches of hawks and owls are nearly the same. Ecologists have observed that no two populations occupy exactly the same niche. They call this concept the **law of competitive exclusion**. The law says that if two species occupy the same niche, one will totally replace the other over time. This is because one of them is usually better at competing for resources than the other. You could say it is better adapted. This is also called **Gause's principle**.



Check the definition of this principle on page 594 in your text.

Read the following case history.

The Mountain Bluebird

The mountain bluebird is native to Alberta. It lives on the prairies and on the Eastern slopes of the Rockies. It feeds on insects in open areas and nests in hollows of trees. In winter, it migrates to the Southern U.S.A. When it returns in spring, it looks for a nesting site. If a tree hollow is occupied, the bluebird will not intrude but look for another nesting site.

A European bird, the starling, which was introduced into North America in the 1850s, occupies the same hollows in trees as does the mountain bluebird. The starling is not migratory and will take over old mountain bluebird nesting sites.

Another European bird in North America, also not migratory, is the house sparrow. It, too, competes for the same nesting sites.

Science Skills

- ☐ A. Initiating
☐ B. Collecting
☐ C. Organizing
☒ D. Analysing
☒ E. Synthesizing
☐ F. Evaluating

5. Predict what will happen to Alberta's mountain bluebird population. Explain your prediction.

No doubt, the answer that you gave referred to the niche for which the birds compete. An organism's very survival depends on whether it has a niche available. Polar bears can't survive in Alberta for lack of a niche. Loss of a niche may result in extinction.

6. Give several reasons why organisms may become extinct. Describe these reasons as changes in an organism's niche.



COURTESY OF D. MERRILLS

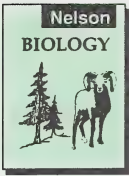
Humans can help other organisms whose niche has been changed. Have you seen nest boxes like this one along country roads? These nest boxes provide an important niche for birds like the mountain bluebird.

Check your answers by turning to the Appendix, Section 1: Activity 2.

If a population is adapted to its environment, the structures (physical traits) of the individuals will reflect that adaptation. For example, if birds are adapted to fly in the air, they must have wings. So when you study an organism's physical features, you see its **adaptations** for survival.

Read over Importance of Adaptation on pages 96 and 97 in your text for a more complete definition of adaptation. Do not read any further.

adaptation an inherited trait that improves the chances of survival and reproduction of an organism



If you have access to the laser videodisc *The Living Textbook*, you can view the importance of adaptation in frame 2705 on Side 1. Several different adaptations can be seen in frames 45271, 45522, 45624, 41000, 44112, 38467, and 40155. Notice some of these adaptations are morphological (structures), some are behavioural, and some are physiological.



frame 2705



frame 45271



frame 45522



frame 45624



frame 40155



frame 41000



frame 44112



frame 38467

So when do you know you are looking at a real adaptation? Try this next investigation.

Investigation: Adaptation to Acidic Soil

Objective

Investigate a morphological and physiological adaptation that has evolved over time to let an organism occupy a particular niche.

Background Information



COURTESY OF D. MERRILLS

You should recall that pH can vary in aquatic and terrestrial environments. Soil pH is important to plant growth. Soil pH varies from place to place in the biosphere. It may even vary in different sections of a single field. Soil pH influences the kinds of plants that can grow in an area and also how well they grow. Plants that can grow well in soils with an acidic pH have an advantage over plants sensitive to acidic soil when both are competing in the same area. Similarly, plants that are adapted to acidic soil may be economically important as food crops. Both of these situations exist for wheat. Wheat is an economically important crop in Alberta. Many soils in Alberta are relatively acidic. Tolerance for acidic soil varies amongst different types of wheat. A type of wheat that grows well in acidic soil may be useful. This would be a noteworthy adaptation to study.

Materials

- 2 petri dishes with lids
- 20 Type A wheat seeds (Katepwa)
- 20 Type B wheat seeds (Cutler)
- 4 Styrofoam cups*
- 4 cup volume of soil
- aluminum sulphate to acidify soil
- * supplied by student
- metric ruler
- hand lens
- plastic wrap*
- paper towel*
- tweezers



Caution

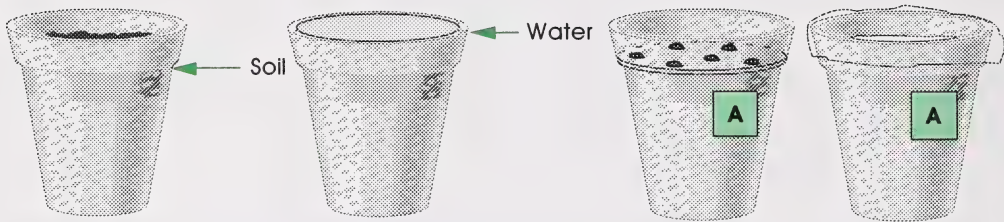
Procedure

This procedure involves sprouting seeds in water and then growing plants in soil. This is done once to test germination and growth in normal soil and then repeated in acidic soil.

Part A: Germination and Sprouting

- With tape, a felt pen, wax pencil, or any other method you can devise, label one petri dish, Dish A and the other Dish B.
- Half fill each petri dish with water.
- Place ten Type A seeds in Dish A and ten Type B seeds in Dish B. Separate the seeds so they are not touching one another.
- Cover the dishes and set them aside for twelve to twenty-four hours.
- After twelve to twenty-four hours, examine the seeds for signs of sprouting. Sprouted seeds are swollen and may have a small shoot beginning to emerge.
- Label one Styrofoam cup, Cup A and the other Cup B.
- Fill each cup with soil up to the inside shoulder. Pack the soil lightly.

- Add water to fill each cup and let the water soak in.
- Now it's decision time. Choose the six most sprouted seeds from each petri dish and place them on the damp soil in the appropriate cup. Be careful not to break the new shoots off the seeds. Arrange the seeds to space them out evenly.
- Cover the seeds with soil equal to their own thickness (about 0.5 cm). This is a general practice in planting.
- Lightly pack the soil.
- Add water to the top of each cup again and let it soak in. Add the water gently so it doesn't wash the seeds away.
- Cover the Styrofoam cups with plastic wrap to prevent dehydration and set them aside in a sunny location if possible.



- Let the seeds sprout and grow for three days. The shoots may start to lift the plastic wrap.

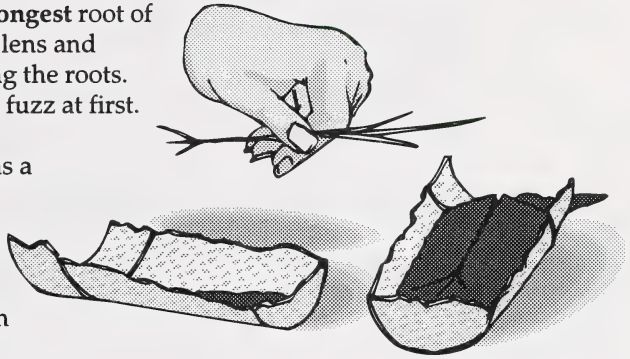
Now it's time for another decision.

- At the end of three days, remove the plastic wrap and gently **pull out** the two **smallest** or **weakest** plants from each cup. What you are doing is selecting the strongest plant for continued growth.
- Add a little water to keep the soil damp and set the cups in a sunny location, if possible, for another five days.
- At the end of five days carefully break open each Styrofoam cup and loosen the soil so the plants can be removed whole and with all roots attached.
- Remove the entire plants of each type. Gently shake and rinse the soil off the roots of each plant.
- Lay the plants out on a paper towel. Do not mix up Type A and Type B.

- Measure the length of the **longest** root of each plant. Use your hand lens and look for tiny root hairs along the roots. These may appear as white fuzz at first.

- Record your observations as a comparison of Type A and Type B development.

- Calculate and record the average root length for each type on your data table.



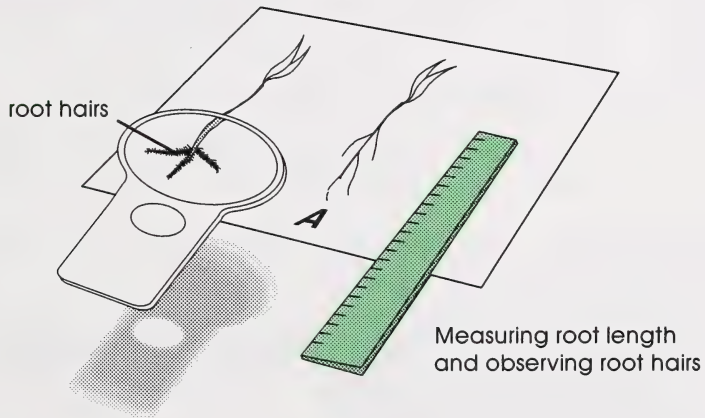
Science Skills

- ☐ A. Initiating
- ☒ B. Collecting
- ☐ C. Organizing
- ☐ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

Observations

Sample Table: Normal Soil

	TYPE A PLANTS				TYPE B PLANTS			
	1	2	3	4	1	2	3	4
root hairs present								
longest root length								
average root length								



7. Was there any difference in the growth and development of Type A and Type B seeds?

Check your answers by turning to the Appendix, Section 1: Activity 2.

Having established the technique for sprouting wheat and measuring root development, you are now ready to go on to Part B. In this part you will create an acidic soil and determine acid tolerance in Type A and Type B plants.

Part B: Acid Tolerance Test



- Add the aluminum sulphate to the remaining soil and mix thoroughly.

Do not get any chemical on your skin or in your eyes. If you do, rinse immediately with plenty of cool water. Seek medical attention if irritation persists. Aluminum sulphate is relatively safe to handle, but you should treat any chemical with caution.

- Label one Styrofoam cup, Cup A and the other Cup B.
- Add the acidified soil to each cup as before.
- Sprout ten seeds of each type in water as in Part A.
- Select and plant the six most sprouted seeds of each type in the appropriate cup as you did in Part A.
- Cover with soil, add water, and plastic wrap as before.
- Set aside for three days; then carefully remove the two weakest sprouts from each cup.
- Allow the remaining sprouts to grow another five days.
- At the end of five days remove the plants as in Part A and compare their root development.
- Construct a second table for data.

Sample Table: Acid Soil

	TYPE A				TYPE B			
	1	2	3	4	1	2	3	4
root hairs present								
longest root length								
average root length								

Analysis and Interpretation

8. Compare plant growth **above the soil** for Type A and Type B plants in Part B.

9. Compare root development in Part B by describing what you have observed about acid tolerance and acid-sensitive roots.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

10. a. Why did acid tolerance characteristics **not** show up in Part A?

b. What was the selective agent in Part B?

c. What role did the selective agent play in Part B?

d. Predict what would happen if an acid-sensitive and acid-tolerant plant were grown in neutral soil.

e. Predict what would happen if the plants in question 10. d. were grown in acidic soil.

Check your answers by turning to the Appendix, Section 1: Activity 2.

The development of acid-tolerant wheat is a research topic in the Department of Plant Science in the Faculty of Agriculture and Forestry at the University of Alberta, Edmonton.

Cutler is one type of wheat being developed that is adapted to acidic soils. This adaptation represents a genetic change in the plant and can be passed to future generations. Think of the possibilities.

ACTIVITY

3

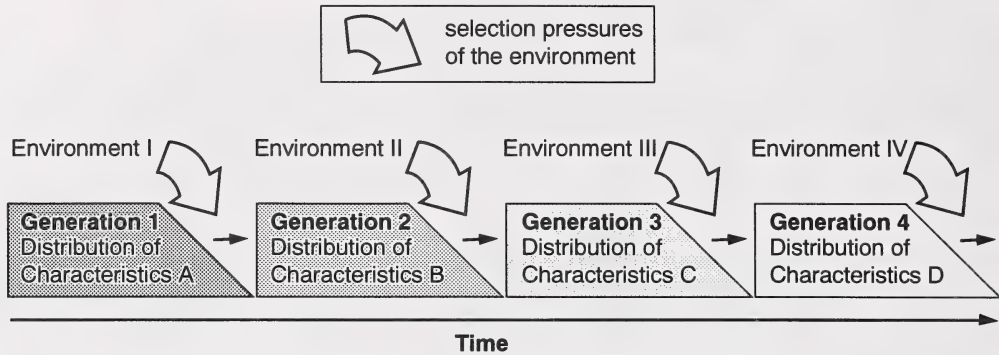
Time for a Change

"If you can't stand the heat, get out of the kitchen." This is good advice. But where do you go? The Earth is warming up. Climates are changing and, therefore, environments are changing. Populations that are perfectly adapted to their environments gradually find them changed. Do populations have to leave their environment in order to avoid any changes? Well, not if they can adapt. If the change is not too quick and if they have the right variations, populations can adapt; otherwise, they may become extinct.



Ecosystems are always changing naturally; populations must change with them. The whole process is summarized in the following conceptual diagram.

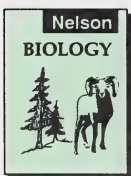
You can apply this diagram to the mountain bluebird situation described earlier. You just need a bit more information.



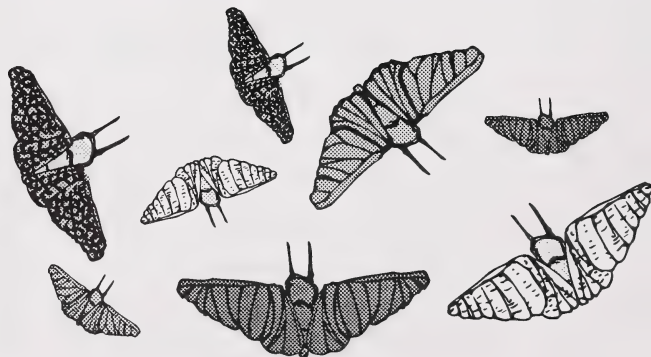
About ten years ago mountain bluebird enthusiasts began placing nest boxes near open fields and along roads where mountain bluebirds look for insects to eat. The boxes had holes exactly 3.7 cm in diameter, too small for starlings to enter. This action increased the number of nesting sites available. Nest boxes were often examined by enthusiasts and cleared if other birds were using them. Mountain bluebird numbers increased.

1. How did the environment change for mountain bluebirds when starlings were introduced and change again when nest boxes were made available?
2. What change might you expect where mountain bluebirds are normally found due to this human activity?

Check your answers by turning to the Appendix, Section 1: Activity 3.



That populations change over time is also illustrated in the case study of the peppered moth, *Biston betularia*. Read the Case Study on pages 109 and 110 in your text and answer the following questions.



3. Identify the trait that made the peppered moth well adapted to evade predators in the first half of the 1800s? How did that trait enhance survival?
4. Describe the alternate form (variation) of the moth trait which also existed then?
5. In what two ways was the environment of the peppered moth changed by the Industrial Revolution.
6. Name the agent of **natural selection** that determined which form of peppered moth would be most likely to survive.
7. Describe the change in distribution of traits that took place between the mid-1800s and the late 1800s.

Change in the peppered moth colouration did not produce a new species. Nevertheless, even small changes can be significant to survival.

Problems with Adaptations

Sometimes changes in populations can be detrimental to you. If you want to kill insects that eat your crops, you can spray them with insecticides such as DDT. But what if there are a few insecticide-resistant insects in your target population? Their body chemistry prevents the spray from killing them. These surviving insects will pass their resistance on to their offspring, and soon the pesticide-resistant forms will grow into a large, hungry population that you can't stop – unless you use a new or stronger pesticide. And what if there are a small number of survivors this time?



PHOTO SEARCH LTD.

There are already hundreds of insects and spiders that are resistant to common pesticides. There are also many disease-causing organisms becoming resistant to modern antibiotic drugs like penicillin.

8. Explain why insect populations change faster than elephant populations.

Check your answers by turning to the Appendix, Section 1: Activity 3.

Eurasian water milfoil is an aquatic plant that has invaded Alberta lakes and is better adapted and more competitive than many native plants. It chokes shallow water and makes activities like swimming, boating, and fishing nearly impossible. Milfoil may be spread from lake to lake by plants attached to boating equipment. To make people aware of this problem and prevent the further spread of milfoil, signs like this are placed along Alberta highways.



COURTESY OF D. MERRILLS

herbicide – a chemical that kills plants

Milfoil is a tough plant. **Herbicides** that could be used to kill milfoil in lakes would also kill all other native aquatic plants. You can imagine the effect this would have on food chains in the aquatic ecosystems. People must help this problem with responsible environmental behaviour – like cleaning weeds from their boating equipment. Can you think of other solutions?

Follow-up Activities

If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

1. Complete this definition of a population by filling in the missing words.

A population is a group of _____ of the same _____ occupying the same _____ at the same _____.

2. Fill in the blanks in the following statement using these terms:

• birth • carrying capacity • death • environmental resistance

In a growing population the _____ rate is higher than the _____ rate. A population stabilizes when it reaches the _____ of its environment. The environmental constraints on population growth are called _____ or limiting factors.

Although populations are composed of members of the same species, there are many differences between the individuals that comprise it. An example of a species that shows great variation is the corn plant, *Zea mays*. Some plants are small and look like grasses, others are taller than a man and much thicker than grasses. Think of the seed produced by corn. How many variations in just the seed can you think of?

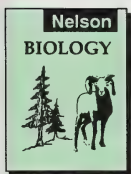
3. Identify as many variations as you can from the photo on page 484 in your text. How many different seeds are there?

Recall that the niche of an organism is its place in the ecosystem and everything that it does to survive and reproduce. Various structures of an organism may enable it to occupy and function in its niche. Look at the beaver in the following picture.



PHOTO SEARCH LTD.

4. Give examples of beaver structures that make them suited to their habitat. Describe what the structures are used for.



Purple loosestrife is another European plant that is now invading Alberta's lakes, sloughs, and bogs. It occupies exactly the same niche as native cattails.

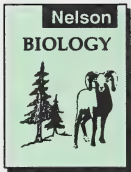
coexist – to live in the same niche as another organism

5. Predict if these two plants will be able to **coexist**. Explain why or why not. Refer to page 594 in your text. See Gause's principle.



DUCKS UNLIMITED

By now you should appreciate that most populations are adapted to their environments.



6. Read pages 111 and 112 in your textbook and give an example of each of the following adaptations; explain how it helps the organism function in its environment.
- structural adaptation
 - physiological adaptation
 - behavioural adaptation

Check your answers by turning to the Appendix, Section 1: Extra Help.

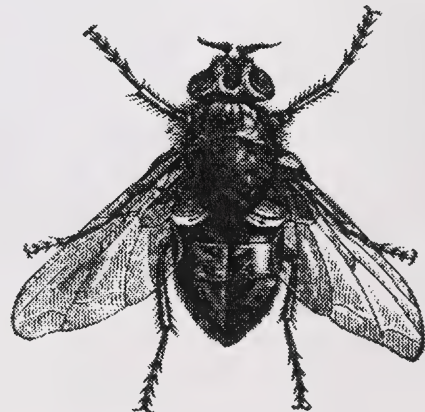
Enrichment

Do one of the following.

1. This activity will give you an opportunity to practise the skills used by actual population ecologists.

You may have heard that population growth is exponential. This means that if a single housefly lays 120 eggs, within six generations there would be 6×10^{12} houseflies! Fortunately, not all of them survive.

But just what is exponential growth?



It simply means that as a population grows, the number of young that are produced by each generation increases. Imagine a population of mice with ten females and ten males. Each female has twelve offspring a year and two of the mice die in each generation each year. The reproduction rate of the population is calculated in the following way:

$$\frac{\text{births} - \text{deaths}}{\text{original population}} = \frac{12 - 2}{20} = 0.5 = \text{reproduction rate}$$

- a. Determine how many mice there are in each generation in the table by multiplying the reproduction rate with the population of the previous generation. Fill in the rest of the table.

GENERATION	NUMBER	REPRODUCTIVE RATE	INCREASE
1	20	0.5	10
2	30	0.5	15
3			
4			
5			
6			
7			
8			
9			
10			

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☒ C. Organizing
- ☒ D. Analysing
- ☒ E. Synthesizing
- ☐ F. Evaluating

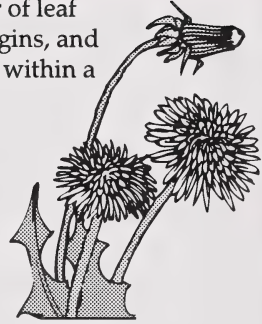
Notice how each generation produces an increasing number of offspring. This is what characterizes exponential growth.

- b. What effect does exponential growth have on the overall population? You can draw a graph to illustrate this. Plot population on the vertical axis and time on the horizontal axis. Title and label the graph.
 - c. In natural populations what kinds of things happen to prevent the kind of population growth shown on your graph?
2. Choose an area in your neighbourhood where dandelions, *Taraxacum officinales*, grow abundantly. From each of thirty plants, none growing closer than five metres together, collect one large leaf. Bring the leaves home or to school.

Study the shapes of the leaves carefully. Look for the number of leaf indentations, the depth of indentations, the points on the margins, and any other things that stand out. You are observing variations within a single species.

Divide the leaves into groups that seem to fit together. How many distinct types of dandelion leaves did you find? Draw each distinct shape and describe it.

3. Read over the Case Study on page 114 in your text. Contact a district agricultural office in your area and ask for information on pesticide resistance.



Introduction

During the past decade, a number of native Alberta birds like the Black-capped Chickadee and Mountain Bluebird have come under increased pressure due to man's encroachment on their natural habitat. AGT's Feather Care program was developed to provide alternate nesting sites for these and other species. In becoming involved with this exciting program, you've joined AGT; Alberta Forestry, Lands and Wildlife; and many other concerned groups and individuals like yourself, in helping to re-establish these bird populations.

Along almost every rural road and secondary highway in Alberta, you'll find buried communications cable in the ditch running parallel to the roadway. The vicinity of this cable is identified by highly visible markers placed on mounting posts approximately every 500 metres. That adds up to over 700,000 markers throughout the province.

In 1989, AGT employee, Brian Cowan came up with the idea of converting the cylindrical markers into nest boxes.¹



Mountain Bluebird
(*Sialia currucoides*)



COURTESY OF D. MERRILLS

¹ Courtesy of Alberta Government Telephones.

If you live in a rural area, travel along any road and watch for these orange, buried cable markers. You can participate in converting these markers into useful bird houses.

4. Contact the AGT Regional Coordinator in your area for information. Ask for the booklet *Feather Care*.



Black-Capped Chickadee
(*Parus atricapillus*)

== AGT Regional Coordinators ==

The administration of the Feather Care program has been divided into seven Alberta regions, each headed by an AGT regional coordinator. The seven AGT regional coordinators along with their Alberta Forestry, Lands and Wildlife counterparts are responsible for the implementation of the program. If you experience any difficulties or have any concerns which are not addressed in this guide, contact your regional coordinator, they will gladly assist you.

Calgary Region	530-8580
Edmonton Region	493-2850
Grande Prairie Region	624-7856
Lethbridge Region	382-2408
Medicine Hat Region	529-3447
Red Deer Region	341-8474
Vegreville Region	645-3500

If your nest box or mounting post is damaged or destroyed, please contact your AGT regional coordinator immediately and arrangements will be made for replacement. Your regional coordinator is responsible for the distribution of nest box conversion kits, decals, printed materials, and promotional items.¹

AGT Regional Boundaries



¹ Courtesy of Alberta Government Telephones.

5. If you have a copy of *Biology, A Canadian Laboratory Manual* by Ritter, Drysdale, and Coombs, consider doing lab 33 Population Growth on page 155.

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

Populations are groups of organisms. Each population is composed of a single species and occupies a single complex niche. Although members of a population are of the same species, they are not identical. Variation occurs between individuals. Variations may help some members survive and reproduce better than others. These helpful variations are called adaptations and will be passed from generation to generation in continuing life in the biosphere.

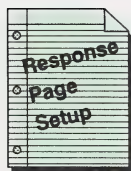
45

Section 1 Assignment: Populations Have Variations

Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:

Biology 20 – Module 4 Section 1 Assignment Page # Name and ID#



Be sure to write legibly. Leave a wide left margin and number all of your pages.

Read the following excerpt and then answer questions 1 and 2.

Wildlife & Nature

By Leonard Lee Rue III Desert Deer

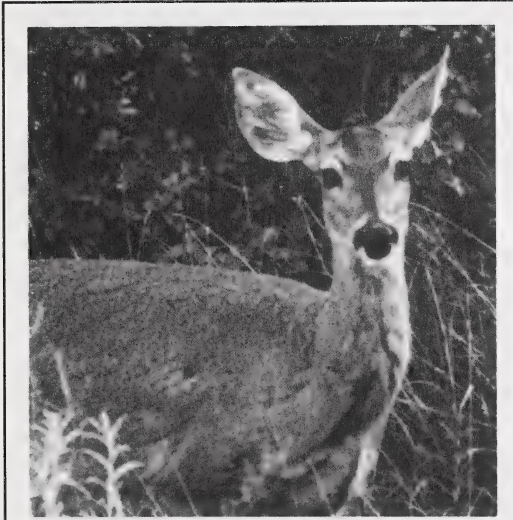
All deer living in desert regions have developed special adaptations that permit them to survive the harsh environment. One of the most noticeable is their oversized ears. Mule deer were so named because their big ears reminded early settlers of mules. Animals that live in open areas tend to have larger ears than their kin in areas of adequate protective cover. The oversized ears are needed to

warn the open-area animals of danger when it is still a long way off. They can then either move away from the potential threat or seek out whatever cover is available.

Animals that live in the desert also have oversized ears because they act as thermoregulatory appendages. During the extremely hot days of summer the animal is able to dissipate much of its body heat as blood flows through vessels in the ears – where it is cooled slightly before reentering the body. And when the desert cools – often it gets

very cold at night and in the winter – the extra blood that flows through the ears to cool the body in summer keeps them from freezing.

Although we commonly think of the desert as being a place of little water, many of the plants are succulents or have other water-retaining properties. Many cacti are veritable storage tanks of water. Perhaps desert deer are getting a larger percentage of their daily water requirements from vegetation than are woodland deer. To further reduce the need for water, desert deer move



Desert-dwelling deer use their over-sized ears to listen for possible approaching danger and as "radiators" to help cool circulating blood.

only after shadows have stretched to the limit and temperatures have cooled.

There is no question, however, that desert deer need, and utilize, whatever water sources are available. Deer frequent whatever natural seeps, springs, pools, ponds, streams, and rivers that may exist. Stock tanks and impoundments have allowed them to spread into new areas. In most deserts, however, all or most of these water sources are scarce or nonexistent, which puts the deer in direct competition with every other creature, particularly imported wild burros and horses. Because of their water consumption, these feral animals are a constant threat to our native deer, pronghorns, and wild sheep.

But burros and horses aren't the only threat to desert mule deer. They are also threatened

by their more numerous and aggressive cousins, the Texas whitetails. The constant expansion of Texas whitetails into west Texas is an encroachment on what once the exclusive realm of the desert mule deer. Not only is the whitetail now competing with the muley for food, water, and cover, it has biologists fearful that whitetails will breed the muleys out of existence. By that I don't mean that whitetails will just produce more offspring than muleys, but that they will actually crossbreed with mule deer to the loss of that species' identity. The idea is not as farfetched as it seems. Crossbreeding is not only happening in west Texas, it is also occurring in the Canadian provinces of Saskatchewan and Alberta.

For years biologists claimed that mule deer and whitetails would not interbreed. Then it

was thought that if crossbreeding did take place the offspring would be infertile. Now we know that such crossbreeding does take place, that the young are fertile, that it is occurring on a much larger scale than was previously thought possible, and that the offspring's characteristics will eventually favor whitetails over mule deer.

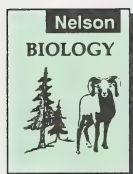
It all comes down to the aggressiveness of the whitetail buck. When a doe of either species comes into estrus, she will attract both whitetail and muley bucks. The whitetail buck, being more aggressive, pursues the doe relentlessly, so much so that when she is bred it is to the whitetail. As this is the consistent pattern, each succeeding generation over the years will favor whitetail characteristics. It is possible that in only four or five years the characteristics of some mule deer populations will have been supplanted completely by Texas whitetails. Such a transformation symbolizes the evolving world of our desert deer.¹



Aggressive whitetail bucks are interbreeding mule deer, threatening their future in some desert areas.

¹ For the excerpt from *Desert Deer* by Leonard Lee Rue III, *American Hunter*, June 2, 1992, p. 12. Reprinted with the permission of Leonard Rue Enterprises.

1. How are desert deer adapted in the following ways: **(10 marks)**
 - a. structurally
 - b. behaviourally
2. Behavioural adaptations such as courtship or breeding behaviour can provide an advantage to one species over others where two species are very similar. What evidence is given in this article that this may be occurring? **(5 marks)**
3. Read the Case Study on pages 114 and 115 in your text and answer the following question: **(10 marks)**
 - a. Do Case Study questions a., b., c., and f.
 - b. Speculate what might be the effect on the proportion of DDT-resistant mosquitoes to nonresistant mosquitoes if the use of DDT were stopped for five years. Include a discussion of DDT as a selective agent.
4. Refer to the Case Study: Resistance to DDT on page 114 in your text. **(10 marks)**
 - a. Explain how this case study strengthens Darwin's theory that some variation exists in populations.
 - b. Explain how the case study strengthens Darwin's theory that these variations are acted on by natural selection.
5. Use the Case Study: Adaptation and the Peppered Moth on page 109 in your text for this question. Even a population of dark-coloured moths retains genetic factors for light colouration. Speculate what would happen if environmental conditions were reversed in the case of the peppered moths in England. **(5 marks)**
6. The tapeworm *Diphyllobothrium latum* produces millions of eggs and can infect a wide variety of host mammals such as dogs, rats, bears, and humans. Explain how variation in possible hosts may be the result of high egg production. **(5 marks)**



Populations

Evolve



COURTESY OF DUCKS UNLIMITED

Have you ever seen five thousand organisms in one place, like five thousand people at a hockey game or five thousand geese in a field? Look at the geese in this photo. There may be over five thousand geese in this population. Like a single organism, this population feeds, grows, and interacts with other organisms in its environment. Together with other living things, this population exists in a dynamic relationship. How do you suppose this came to be?

To understand such a relationship between living things, you have to study the theory of evolution.

You also need to study the fossil record and other views on evolution. Throughout this study you will notice and appreciate how scientists work to discover and reconstruct life in the past, and you will see how the scientific thinking about evolution has progressed over the years.

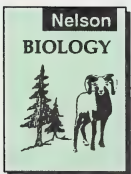
In Section 1 you learned how small changes in a population can occur. The environment, as you recall, plays a role. In this section the concept of changes in populations is stated in more general terms – as it applies to all populations. Also, here you will see the combined effects of many changes in a population over a long period of time. The end result is evolution.

ACTIVITY

1 Digging for Evidence



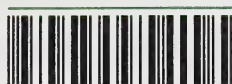
Paleontologists study organisms that lived long ago. They may be able to tell you the age of the specimens they are uncovering, the environmental conditions under which they lived, and who their ancestors and relatives were. Moreover, paleontologists add data to the bank of evidence that supports the theory of evolution. Fossil evidence is direct evidence for evolution.



Read pages 97 to 100 in your text and answer these questions.

1. Define paleontology.
2. What do paleontologists look for?
3. Record your textbook definition of *phylogeny*.
4. List four examples of the kinds of data on which phylogenies are based.
5. How do scientists determine the age of fossils?
6. Differentiate between the fossils found in old rock and those found in new rock.

If you have access to the laser videodisc *The Living Textbook*, look at the fossils and fossil bone on Side 1 frames 2922 and 2250-2252.



frame 2922



frame 2250



frame 2251



frame 2252

Check your answers by turning to the Appendix, Section 2: Activity 1.

Investigation: Exploring a Fossil Lineage

lineage – line of descent between ancestral and modern forms of the same organism

Years of digging, scraping, and sifting have revealed the **lineages** of many modern organisms. Some are incomplete and sketchy, while others are near-complete. The lineage of the modern horse, *Equus*, is a classic example of the latter, on which this investigation is based.

Objective

Gather and analyse data on a species of animal to demonstrate how that organism's morphology has evolved over time.

Background Information

The toes, molars, and height of the modern horse have evolved over the last 55 million years. Horses were found living in both America and in the Old World. They became extinct in America at the end of the Pleistocene era. Fossils of ancestral horses are found today on both continents.

Material

A chart showing equine evolution is needed.

Procedure

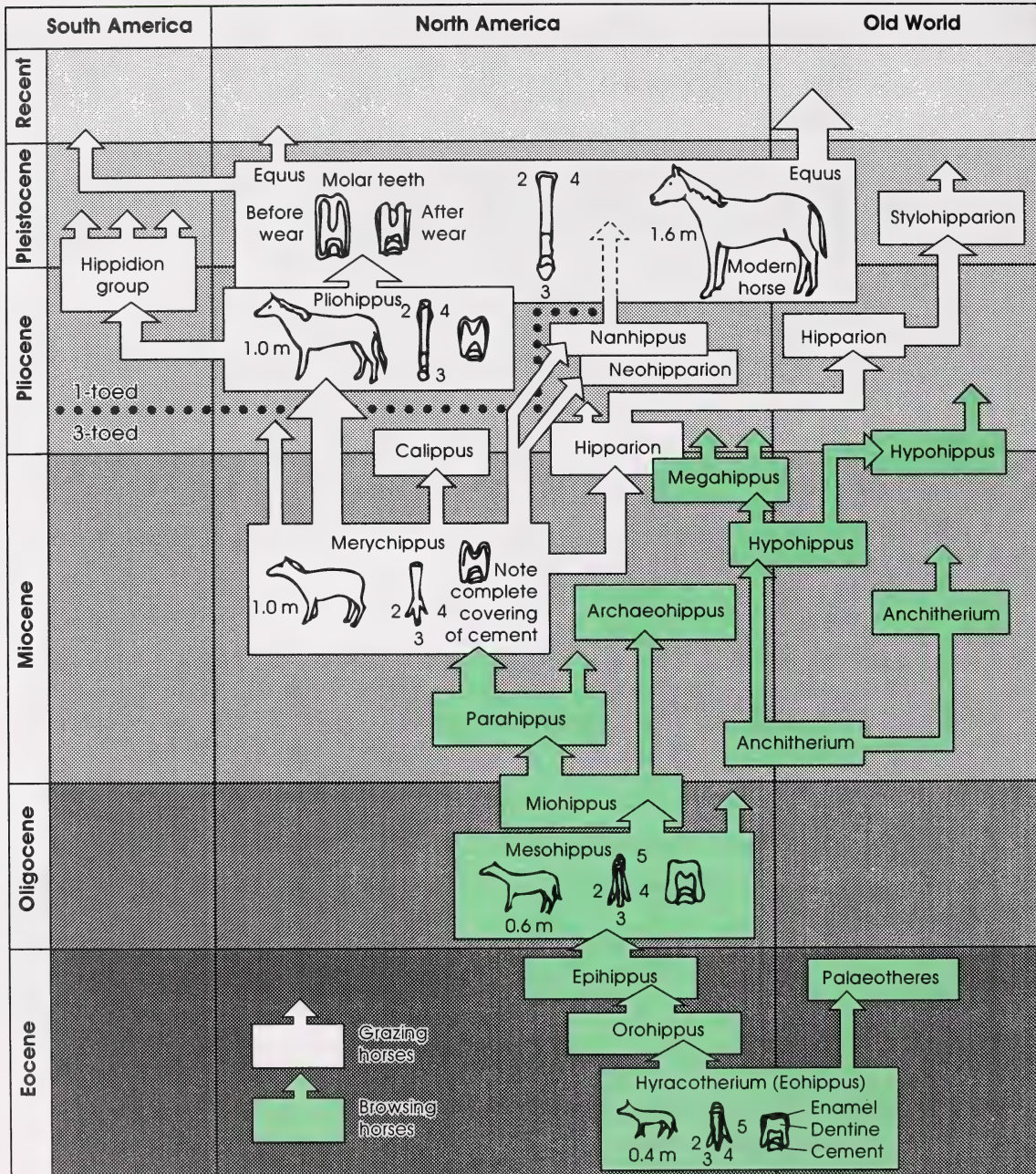
Using the chart on the following page, analyse the heights, molars, and toes of ancestral horses and the modern horse. Here are the terms you should use to describe them:

- height: State in metres to one decimal place.
- molar: Describe height as small, medium, or large; describe cover as enamel or cement.
- toes: State the number.

Observations

Record your observations on the table.

EQUINE EVOLUTION



7.

	HEIGHT	MOLAR COVERING	MOLAR HEIGHT	DIGITS
Equus				
Pliohippus				
Merychippus				
Mesohippus				
Hyracotherium				

Analysis and Interpretation

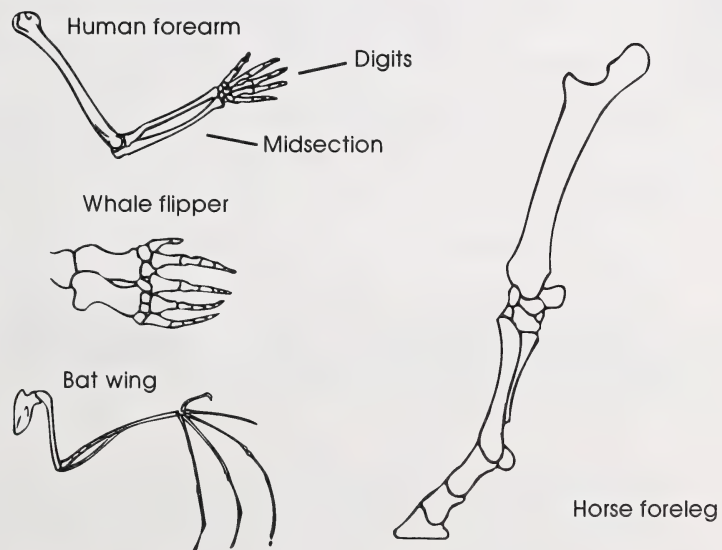
8. How does the fossil record of the lineage of *Equus* show the evolution that has taken place?

Check your answers by turning to the Appendix, Section 2: Activity 1.

The fossil record of the evolution of the modern horse is but one of many records.

In your investigation, you focussed on the evolution of one organism – the modern horse – and several of its structures. In this exercise you will change that focus to one structure as it appears in several different organisms.

Examine the various forelimbs in this drawing.

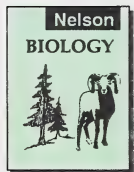


9. Compare these forelimbs and record the data on the table provided. You may also refer to page 111 in your text.

Science Skills

☐ A. Initiating
☐ B. Collecting
☐ C. Organizing
☒ D. Analysing
☐ E. Synthesizing
☐ F. Evaluating

	NUMBER OF BONES JOINING LIMB TO GIRDLE	NUMBER OF BONES IN MIDSECTION	NUMBER OF DIGITS
Human forearm			
Whale flipper			
Bat wing			
Horse foreleg			(fused)



The four structures compared in the table are called homologous structures. Read the section that deals with homologous and analagous structures on page 101 of your text.

10. Answer review question 4 on page 104 of your text.
11. What do similarities in homologous structures suggest?
12. You have seen that vertebrates have evolved quite a variety of different forelimbs. Read page 111 of your text to find the adaptive functions of the forelimbs of the following:

• humans

• bats

• seals

If you have access to the laser videodisc *The Living Textbook*, look at the homologous structures on frames 2588 and 2589 on Side 1.



frame 2588

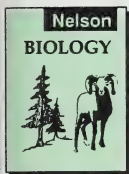


frame 2589

Check your answers by turning to the Appendix, Section 2: Activity 1.

ACTIVITY

2 Theoretically Speaking



Do you generally accept everything you hear as the absolute truth? Most people don't. Generally people compare what they hear to what they have actually experienced; then they form a personal theory. Science is no different. Explanations for phenomena are often theories or ideas. These may differ amongst people and may change as more information is discovered. The development of the theory of evolution is a good example. Read the first paragraph of page 105 in your text and then answer questions 1 and 2.

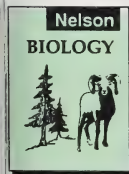
1. How did scientists form their opinions about the natural world before the eighteenth century?
2. What did people believe about the forms of living things?



Today scientists rely on careful observations and experimentation to build a body of knowledge. To see how scientific methods led to the theory of evolution, view the video *Organic Evolution: In the Beginning* and answer the following questions:

3. On what basis did Carl Linneaus decide whether living things belong together in the same group?
4. Because Linneaus organized living things so that species were related through genus, scientists were led to ask what question?
5. What two modern notions did Le Counte Buffon propose?
6. State the mechanism which was proposed by Jean-Baptiste Lamarck whereby living things change.
7. Describe the result of use and disuse of organs or appendages according to Lamarck.
8. Why are Lamarck's ideas of evolution considered invalid by today's scientists (page 106 of your text)?

Check your answers by turning to the Appendix, Section 2: Activity 2.

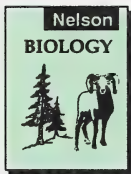


View the second section of the video *Organic Evolution: Darwin, Naturally*. Answer the following questions.

9. Give Darwin's explanation of where modern species came from.

10. Was Darwin able to say how variations in organisms of the same species arose?
11. Describe what breeders of domestic animals do to get their desired results.
12. Briefly explain Thomas Malthus' observation on a population's capacity to grow.
13. What two factors limit the growth of populations?
14. According to Darwin's view of natural selection, which characteristics are inherited? Which are rejected?
15. Record Charles Lyell's principal of uniformitarianism.
16. What process did Darwin see within the layers of deposited rock (geological succession)?
17. What did Darwin call the process that led to the change in organisms?

Check your answers by turning to the Appendix, Section 2: Activity 2.



To appreciate how a new scientific theory develops and to recognize the contributions of various scientists, read pages 105 and 106 in your text. Notice that while Charles Darwin seems to have gotten all the credit, many others contributed earlier ideas of evidence of evolution. Other evidence, while somewhat indirect, is now known.

18. Construct a table of the scientists names, the years they lived, and their contribution.

Check your answers by turning to the Appendix, Section 2: Activity 2.

If you have access to the laser videodisc *The Living Textbook*, view the indirect evidence of evolution that can be seen in the development of amazingly similar embryos. Look at frames 1739 to 1758 on starfish, 1759 to 1785 on sea urchins – close cousins to starfish, and 1786 to 1828 on chicks.



frame 1739



frame 1759



frame 1786

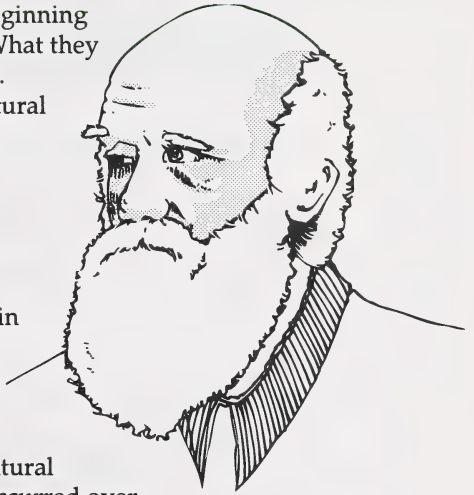
ACTIVITY

3

Darwin, Naturally

In Charles Darwin's time scientists were just beginning to realize that populations change over time. What they didn't know was how these changes took place. Darwin came up with an amazing answer – natural selection.

The theory of natural selection depends on five components. These seem to be a part of all populations in the biosphere.



1. Turn to page 108 in your text where the main ideas of natural selection are given. Read about each idea and then describe it briefly in your own words.

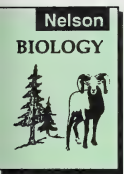
If population characteristics change through natural selection, how much change can occur or has occurred over the ages? Has the human population changed too?

Look again at what Darwin said, this time about finches. Read the information about finches on page 107. Answer the next four questions.



2. How many different species of finches were there on the Galapagos Islands?
3. What made Darwin think that these finches were related?
4. In what way were these finches different?
5. From where did the original finches on the Galapagos Islands come?

How new species arise is described on page 108 of your text, at the bottom of the page, under the heading Origin of New Species.



speciation – the process through which new species are formed

6. In your own words, describe the process of **speciation**.

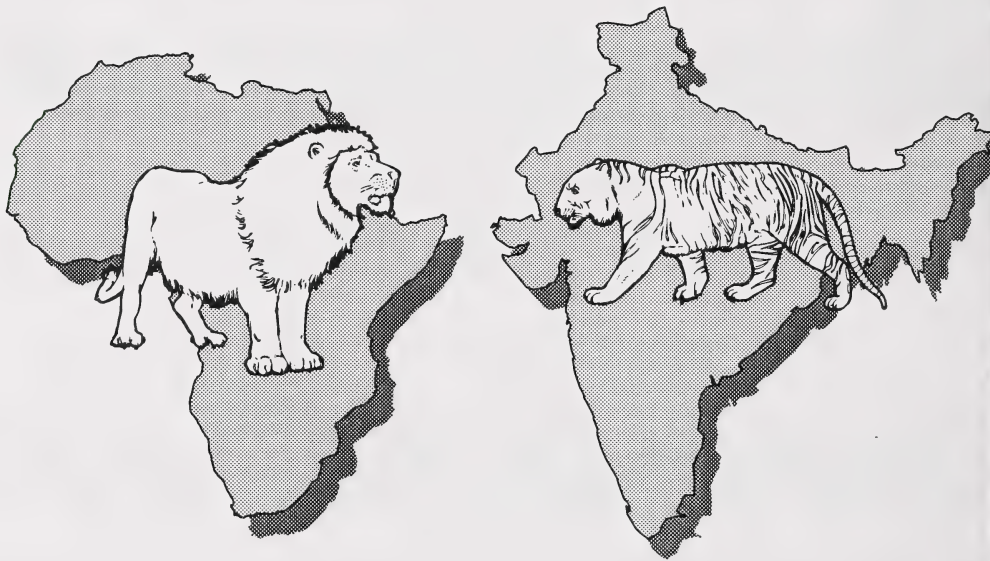
While evolution is still only a theory, it is supported by a possible mechanism, natural selection, and by evidence in the fossil record.

Check your answers by turning to the Appendix, Section 2: Activity 3.

biological isolation – the separation of individuals of a population into distinct breeding groups; also called reproductive isolation

Biological Isolation

A further note on speciation is necessary to complete the picture. In order for speciation to occur, the groups that will form distinct species must be isolated from each other for long periods of time, unable to interbreed. The following diagrams illustrate this concept.

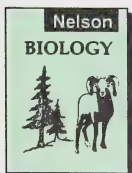


theory – a general idea that logically fits together many observations

Isolation on different continents has theoretically allowed lions and tigers to evolve into two different species even though they may have originated from a common ancestor.

You have seen that scientific ways of knowing involve careful observation and experimentation. In addition, you saw that scientists construct **theories** to explain their observations.

What makes a theory scientific? Read the information about the characteristics of theories in Table 4.1 on page 108 of your text.



Follow-up Activities

If you had difficulty understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

PATHWAYS

If you have access to the video, *Natural Selection*, do Part A.
If you do not have access to this video, do Part B.

Part A

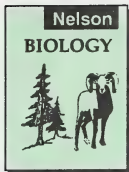
Before you watch the video, familiarize yourself with the questions that follow.

View the first 10 minutes of the video *Natural Selection, Part 1: Natural Selection and Microevolution*; then answer the questions.

1. What did Darwin observe concerning a population's
 - a. number of offspring?
 - b. size over time?
 - c. characteristics of individuals?
 - d. available resources?
2. What kinds of resources does a population need?
3. Give two reasons why individuals of the same population must compete or struggle for existence.
4. In what way are the individuals that survive different from those that don't?
5. Why do individuals that are best suited to their environment have more offspring than others?
6. What happens to the traits that made the parents successful?

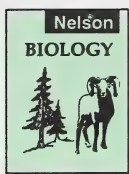
Do not watch the genetics section of the video; it is not part of this course. This part starts when the narrator begins talking about genes. You'll learn about this in Biology 30!

Part B



7. Evolution is a theory that is a possible explanation for how things came to be the way they are. Unfortunately, evolution seems to occur very slowly so it actually is hard to see happening. Evolution is caused by natural selection. At times, natural selection occurs relatively quickly and can be easily studied. Carefully read the Case Study on page 109 in your text and then answer questions a. to f. on pages 109 to 110.

Check your answers by turning to the Appendix, Section 2: Extra Help.



8. Read over pages 105 and 106 in your text and match the names with the concepts relating to evolution that these men proposed.
- | | | |
|-------------|-------|--|
| a. Linneaus | _____ | Populations outgrow their environment's capacity to support them. |
| b. Buffon | _____ | He first proposed that population characteristics change. |
| c. Lamarck | _____ | Organisms with the same physical structures are related. |
| d. Malthus | _____ | Nature selects which traits will survive in a population. |
| e. Darwin | _____ | An organ or structure that is well used will improve and be passed to the next generation. |

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Do one or more of the following.



1. Neo-Darwinism is the name given to modern evolutionary theory. It is a marriage of the ideas of Darwin with those of the science of genetics. To understand how the science of genetics supports Darwin's ideas, view the ACCESS Network video *Organic Evolution: Factoring in Mendel* and answer the following questions.

- a. What was the prime weakness in Darwin's theory?

- b. According to Darwin's critics, if a better-adapted individual – a “wondrous monster” – appears in a population, what will happen to its traits over time?
- c. How did Mendel's experiment with rounded and wrinkled peas disprove blending?
- d. What statement is made about the fate of units of heredity?
- e. In a sealed-off population, what happens to the ratio of dominant to recessive genes?
- f. If the distribution of characteristics in a large population changes, what force is at work?
- g. What do you think could cause a “wondrous monster” to appear in a population?



2. The theory of evolution has undergone many changes over the years. Two views of the process of evolution that have emerged are described in the ACCESS Network video *Natural Selection, Gradualism Versus the Punctuated Equilibrium Theory of Evolution*. View the video and answer the following questions.

- a. What is microevolution?
- b. Why is it that, according to many scientists, organisms cannot be followed through gradual stages of evolution?
- c. What did Niles Eldridge and Stephen Jay Gould propose to challenge the gradualistic model? Briefly describe the kinds of changes seen.
- d. With what events do periods of abrupt change coincide?
- e. Punctuated equilibrium is also associated with “explosions” of populations. Describe two of them.
- f. View the rest of the video and give one more example in support of punctuated equilibrium.

Check your answers by turning to the Appendix, Section 2: Enrichment.



3. Obtain a copy of the COSMOS video *One Voice in the Cosmic Fuge* by Carl Sagan. This program gives an amazing explanation of evolution including possible life on the planet Jupiter.

4. To get information and data on the process of evolution, visit one of the following institutions:

- Tyrrell Museum near Drumheller
- Museum of Natural History (Edmonton or Calgary)

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

Evolution of species and populations is a major concept in biology. It includes an explanation for the origin of the human species as well as all other life forms. Yet evolution and natural selection are still theories and, as such, may change as scientific knowledge expands. Theories are tentative and are strengthened or weakened by further research. In either case, more will become known about how living things exist using matter and energy in the biosphere.

55

Section 2 Assignment: Populations Evolve

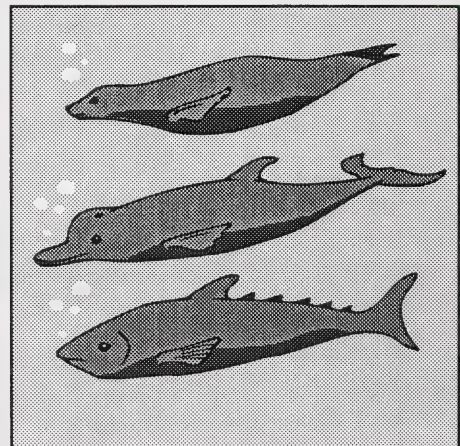
Review the Evaluation information found in the introductory pages of this module.

It is important to number and clearly identify each page with the following information at the top:

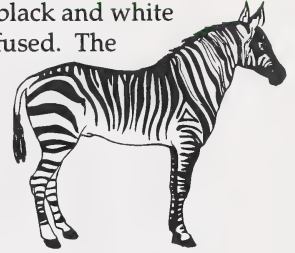
Biology 20 – Module 4 Section 2 Assignment Page # Name and ID#

Be sure to write legibly. Leave a wide left margin and number all of your pages.

1. Seals, dolphins, and tuna all have pectoral appendages (flippers or fins). Describe which of these are homologous and which of these are analogous structures. Explain why. (10 marks)
2. Describe two ways that fossils may indicate phylogeny of an organism. (10 marks)



3. There is an hypothesis that when light is reflected from the black and white stripes of the zebra, an approaching tse-tse fly becomes confused. The fly has difficulty finding its way to the beast to bite it. As a result, and scientists have documented this, zebras are only infrequently infected by the parasite *Plasmodium*, a unicellular parasite carried by the tse-tse fly.



How would Darwin have explained the evolution of the zebra's stripes from an ancestral population? (10 marks)

4. Explain in a paragraph how the modern view of evolution (Darwinian) differs from earlier beliefs. (10 marks)
5. While all organisms in the biosphere reproduce, reproduction has nothing to do with the survival of the individual. In terms of survival, what does reproduction guarantee? (5 marks)
6. Explain how human barriers such as roads, pipelines, or dams may affect the course of evolution and lead to new species. What is this physical effect called? (10 marks)

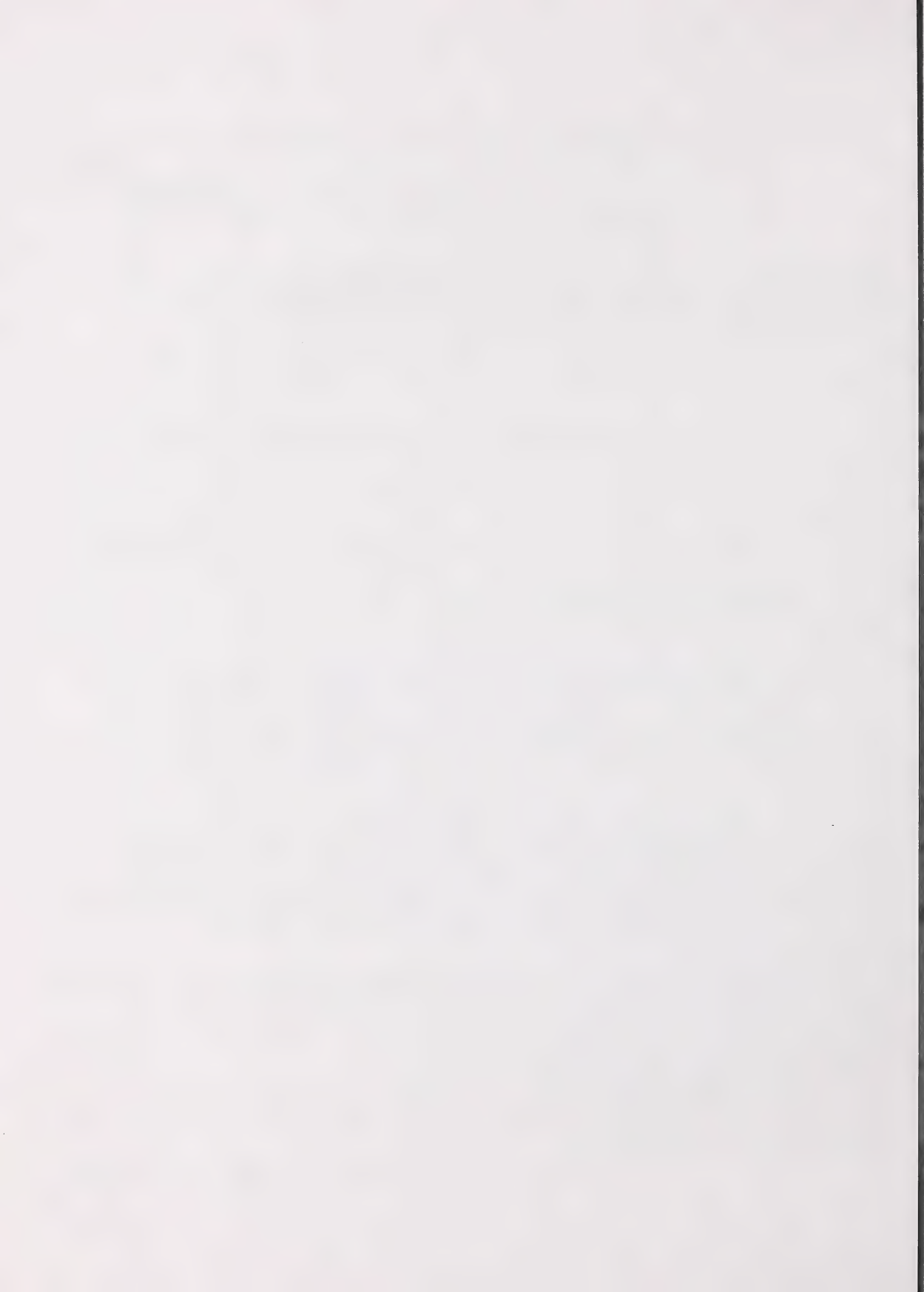
MODULE SUMMARY

The idea that populations could evolve has been long in the making, beginning when humans first domesticated animals in the fertile crescent at the eastern edge of the Mediterranean Sea 10 000 years ago. Humans saw variation and used it in selective breeding. Here and elsewhere a vast array of cattle, dogs, chickens, horses, and pigeons were produced. Little was it realized that nature had been doing this for millions of years before.

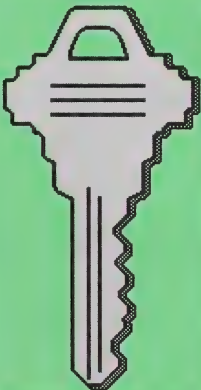
It was not until the late 1800s that the concept of selection was applied to natural populations. The process of natural selection was visible not only on a small scale in present populations but also on a large scale in the fossil record. And, as scientific thinking progressed, the theory of evolution became the concept that unified all life on Earth. This theory has both great explanatory and predictive power, as you shall see in your further study of biology.

To ensure that all of your work has been completed in a satisfactory manner, check off the items in the following list:

- ☐ Section 1 Assignment has been completed.
- ☐ Section 2 Assignment has been completed.
- ☐ Your responses are organized and neat, with room for teacher comments.
- ☐ All your response pages are numbered consecutively and identified with this heading.



Appendix

	Glossary
	Activities
	Extra Help
	Enrichment

Glossary

adaptation: an inherited trait that helps an organism survive and reproduce successfully

biological isolation: the separation of individuals of a population into distinct breeding groups; also called reproductive isolation

carrying capacity: the population an ecosystem can indefinitely support

coexist: to live in the same niche as another organism

habitat: the area of the ecosystem in which an organism lives

herbicide: a chemical that kills plants

lineage: line of descent between ancestral and modern forms of the same organism

natural selection: the process whereby nature chooses which traits survive and are passed on to the next generation

niche: the place and role of a population or individual in its ecosystem

phylogeny: the evolutionary pathway of a plant or animal

speciation: the evolutionary process through which new species are formed

theory: a general idea that logically fits together many observations

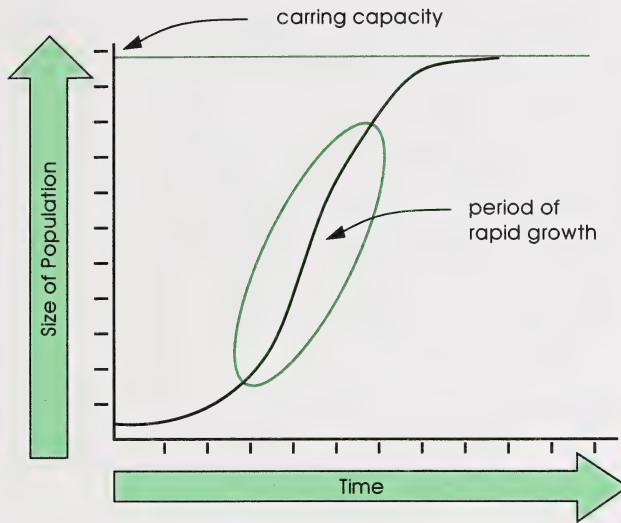
trait: any of an organism's inherited characteristics

Suggested Answers

Section 1: Activity 1

1. Members of a single population look alike; produce fertile offspring when interbreeding; have the same habitat, requirements, and functions; and tend to live together.
2. A population is a group of any species that inhabits a particular area at a particular time. Check the definition on page 576 in your text.
3. Winter severity, predation, availability of nutrients, and availability of winter range will all limit population numbers. Many other factors may also play a role.
4. The two terms used to describe the patterns of dispersal of population members are
 - uniform (spread out evenly throughout the ecosystem)
This term may apply to large areas such as the population of grizzly bears in Alberta.
 - clustered (grouped close together, such as in herds)
This term is usually applied to populations in smaller areas such as the bison in Elk Island National Park.

5. and 6.



7. Disease, behavioral interactions, and migration can control populations.
8. Three examples of human intervention are
 - the removal of excess bison from the population at Elk Island to prevent habitat destruction by overgrazing
 - the reintroduction of the swift (kit) fox on the prairies
 - the stocking of mountain lakes and streams with trout
9. What Malthus means is that the human population can increase much faster than its space or food supply. (By the way, is the space on Earth increasing, decreasing, or staying the same?)
10. In the video, shortages of food, energy, and space are described as limiting factors. You can imagine others such as war or disease. Most likely a combination of limiting factors will play a role.
11. To begin this investigation you must first choose the traits to examine and identify the population.

Traits could include

- | | |
|-----------------------------------|---|
| • eye colour | • ability to roll the tongue |
| • hair colour | • straight or bent (hitchhiker's) thumb |
| • straight or bent little fingers | • left or right top thumb in clasped hands |
| • free or attached ear lobes | • tiny hairs on top of fingers between knuckles |
| • straight or peaked hair line | |

Your study population could be your immediate family, a group of friends, or classmates. Select a couple of traits and pick a population that is easy to work with.



12. Your table will contain your own data; it could look something like this:

TRAITS	VARIATION	NUMBER/NAME OF INDIVIDUALS
Tongue roll	present absent	number: 6 number: 0
Ear lobes	attached detached	number: 4 number: 2
Top thumbs	right on top left on top	number: 3 number: 3

13. It is possible that you would find no variation in some traits in a population and much variation in others. This data becomes very interesting in genetics. Some traits may occur together; for example, all males may have hair on the tops of their fingers.

Section 1: Activity 2

- Adapted to where you live means your appearance, behaviour, structure, and mode of life make you well-suited to live in a particular environment.

2.

ORGANISM	HABITAT
trout	water
squirrel	trees
ruffed grouse	ground
grass	ground

3. A ruffed grouse eats berries, lays eggs in nests and cares for young, has protective colouration which it uses to hide from predators, and can fly short distances to new food supplies or to escape enemies.

Other answers are acceptable.

4. The hawk and owl differ in their hunting time. The hawk hunts during the day; the owl hunts during the night.
5. The population of mountain bluebirds will drop. In time, starlings and sparrows will occupy all existing nesting sites.
6. The following could be reasons why organisms become extinct:
 - A change of climate brings temperatures outside of the niche in which the organism operates.
 - The habitat destruction by man eliminates niches (such as in cutting down rain forests).
 - A newly-introduced organism intrudes on an existing niche.
 - Overhunting by humans removes an organism from its niche.
7. If the soil pH is relatively neutral and no other selective agents are present, growth and development should be the same in Type A and B.
8. If planting and watering were the same for both plant types, the above-the-ground growth will be quite similar. This early growth depends on nutrient in the seeds.
9. Acid-tolerant roots are healthy and vigorous with many root hairs for absorbing nutrients. These roots will support future plant growth. Acid-sensitive roots are short and have few root hairs. They will be unable to absorb water and minerals and will cause poor plant development.
10.
 - a. The soil in Part A was neutral. No selective agent was present.
 - b. In Part B the presence of acidic soil acted as a selective agent.
 - c. In Part B the acidic soil and low pH served to inhibit the acid-sensitive plant. This gave the acid-tolerant plant an advantage.
 - d. In neutral soil the plants would grow the same.
 - e. In acidic soil the acid-sensitive plant would die and the acid-tolerant plant would survive.

Section 1: Activity 3

1. Initially the number of available nest sites decreased and so did the population. As available nest sites increased, the population also increased.
2. Mountain bluebirds would be found more often in open fields and along roadsides.
3. Its whitish appearance with minute dots and speckles was a population trait. Resting on the bark of lichen-covered trees, the moths could not be easily seen by predatory birds.
4. The black-coloured or melanistic moth occasionally appeared. This moth was soon eaten by birds and didn't reproduce.

5. Lichens on trees died; trees became covered with black soot.
6. Predatory birds were the natural selection agent.
7. Almost all peppered moths were whitish in 1848; at the end of the century the population was dominated by black individuals.
8. Insects breed faster than elephants and have huge numbers of offspring. With each new generation there is another opportunity for change.

Section 1: Follow-up Activities

Extra Help

1. A population is a group of **individuals** of the same **species** occupying the same **place** at the same **time**.
2. In a growing population the **birth** rate is higher than the **death** rate. A population stabilizes when it reaches the **carrying capacity** of its environment. The environmental constraints on population growth are called **environmental resistance** or limiting factors.
3. Corn seeds may be yellow, light brown, or dark brown. They may also be smooth or wrinkled. There are six different combinations possible.
4. Teeth for gnawing the bark off branches; webbed rear feet for swimming; claws for grasping and arranging branches; fur to keep out winter cold; and tail to slap water and warn other beavers of predators are all examples of beaver structures that make them suited to their habitat.
5. No, these two plants will not be able to coexist. One inhabitant of a niche is better at exploiting the resources of the niche than other. Gause's principle states that no two species can occupy the same niche at the same time. Competition will eliminate one species. In Alberta there is concern that the purple loosestrife will eliminate native cattails.
6. Structural adaptation: The forelimb of humans is structured for grasping and tool using. Other answers are in your text but notice how each structure helps the organism survive.

Physiological adaptation: The pitcher plant produces digestive enzymes that break down its prey. Notice that most physiological adaptations involve special chemicals.

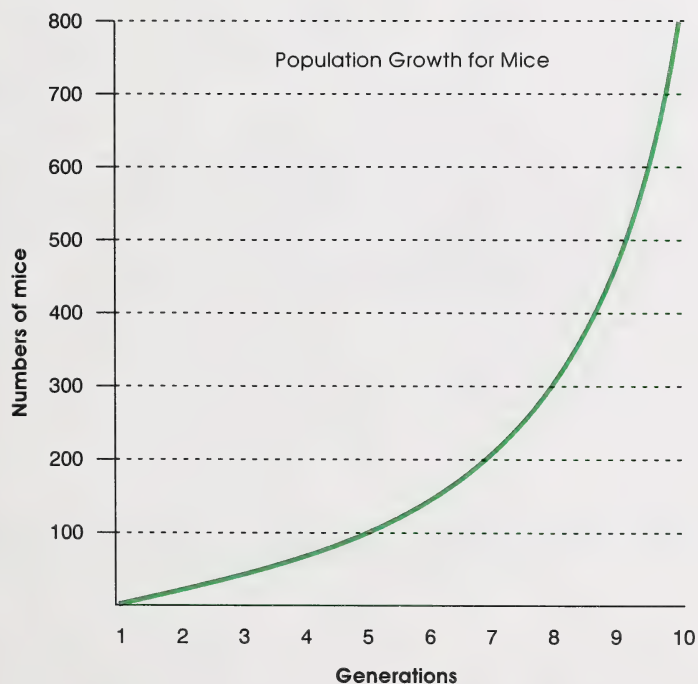
Behavioral adaptation: The Canada goose flies south in winter to avoid cold and to find another food source. Notice that most behavioural adaptations involve action.

Enrichment

1. a.

GENERATION	NUMBER	REPRODUCTIVE RATE	INCREASE
1	20	0.5	10
2	30	0.5	15
3	45	0.5	23
4	68	0.5	34
5	102	0.5	51
6	153	0.5	77
7	230	0.5	115
8	345	0.5	173
9	518	0.5	259
10	777	0.5	389

b.



Populations will run out of food and space, suffer from disease and predation, or destroy their environment to the point where it can no longer support such large numbers.

- c. Generally, large numbers of offspring die before reproducing. Mortality factors could be predation, starvation, cold, or anything that causes an early death.

2. If you don't have the opportunity to collect a large sample of dandelions, try to collect a few leaves from dandelions growing in different areas and look for similarities and differences. Remember, they are all in the same species and easily hybridize.
3. Pesticides are dangerous for a number of reasons. They are toxic to living things. They may enter the body very easily. Once in the body they may accumulate in tissues and organs. No mechanism or system may exist to get rid of the pesticide once in the body. For these and other reasons, science and technology is continually researching methods of biological control of pests instead of chemical control.
4. Buried cable markers that have already been converted to nest boxes have two fairly large holes in their sides and a tin lid. Watch for birds around any of these in your area.
5. Investigations such as this are common for biologists studying mammal populations. Isle Royale in Lake Superior has supported such a study involving wolves and moose for nearly twenty years.

Section 2: Activity 1

1. Paleontology is the study of fossils.
2. Paleontologists look for the remains, impressions, and traces of organisms from past geological ages.
3. Phylogeny is the pathway taken by living things in their evolutionary history.
4. The following are examples of the kinds of data on which phylogenies are based:
 - Phylogenies are mostly based on examining the hard parts of organisms such as teeth, shells, and bones.
 - Frozen carcasses are also examined if they can be found.
 - Imprints of plants and animals along with tracks may be found in stone.
 - Organisms trapped in amber or tar pits are sometimes well preserved and complete.
 - Petrification of plant or animal matter also creates fossils.
5. A common method is to determine the age of the rock containing the fossil. This is done by finding the degree of radioactive decay of various elements in the rocks.
6. The oldest rocks contain simple organisms; recent ones contain complex organisms. Old rocks contain fossils of organism that lived a very long time ago.

7.

	HEIGHT	MOLAR COVERING	MOLAR HEIGHT	DIGITS
Equus	1.6 m	cement	large	one (2, 4 fused to 3)
Pliohippus	1.0 m	cement	medium	one (2, 4 fused to 3)
Merychippus	1.0 m	cement	medium	three (5 is gone)
Mesohippus	0.6 m	enamel	medium	three (5 fused to 4)
Hyracotherium	0.4 m	enamel	small	four

8. One form seems to flow into another as small changes accumulate over millions of years. A short browsing horse with toes has evolved into a tall grazing horse with hooves.
- 9.
- | | NUMBER OF BONES JOINING LIMB TO GIRDLE | NUMBER OF BONES IN MIDSECTION | NUMBER OF DIGITS |
|---------------|--|-------------------------------|------------------|
| Human forearm | 1 | 2 | 5 |
| Whale flipper | 1 | 2 | 5 |
| Bat wing | 1 | 2 | 5 |
| Horse foreleg | 1 | 2 | (fused) |
10. Homologous structures are derived from a common ancestor. The forelimb of a whale and a man are from the same ancestor. Analogous structures have the same function but different evolutionary origins. The wing of a dragonfly and the wing of a bird are analogous structures.
11. Similarities in homologous structures suggest a common ancestry.
12. • humans: grasping • bats: flying • seals: swimming

Section 2: Activity 2

- Before the eighteenth century, humans relied heavily on what they heard or were told in order to form opinions about the natural world.
- It was believed living things were “fixed” and existed much as they did when they first appeared on Earth.
- Some organisms had certain similar characteristics. These shared characteristics indicated the organisms were related.
- Could species have evolved from some prototype or common ancestor?
- Species could diverge from ancestral form and a species could be modified by the environment.
- Inheritance of acquired characteristics occurred and passed characteristics from one generation to the next.
- According to Lamarck, organs or appendages developed as they were used. Those that were disused wilted away.
- Acquired characteristics cannot be inherited. Inheritance depends on genetic change. Use or disuse does not alter genetic makeup.
- Modern species are lineal descendants from extinct species. This means modern species came from ancestral species.
- No, he was only able to say that variations occurred and could be passed on.
- Breeders of domestic animals select animals with desirable characteristics and allow them to reproduce.

12. Living things have the power to reproduce exponentially. Far more offspring are produced than will survive.
13. Population growth can be limited by many factors such as harsh climate and limited food.
14. Those characteristics that tend to preserve the individual are inherited. Those that tend to harm the individual are rejected.
15. Geological activities are uniform. The processes at work today are the very same processes that formed the ancient world.
16. Darwin observed that layers of rock were deposited over time in such a way that new layers lie on top of old ones. Biological succession occurred likewise.
17. The process that led to the change in organisms was called natural selection.

18.

SCIENTIST	DATE	CONTRIBUTION
Pierre-Louis de Maupertius	1751	• Multiplication of species leads to offspring different than ancestral forms.
George-Louis Leclerc de Buffon	1750	• Creation of species happens in many places; species change over time from a common ancestor.
Carl Linneaus	1760	• Linneaus's contribution was the same as Buffon's.
Erasmus Darwin	1794	• Darwin's contribution was the same as Buffon's.
Jean-Baptiste de Lamarck	1800s	• Characteristics changed through use or disuse; the characteristics may be passed on to offspring.
Charles Darwin	1859	• Evolution of new species occurs by natural selection.

Section 2: Activity 3

1. **Overproduction:** Populations produce more offspring than can survive.

Struggle for existence: Individuals must compete for limited resources.

Variation: Individuals are different with respect to characteristics.

Survival of the fittest: Individuals with traits that help them compete will survive and reproduce.

Origin of new species: With increasing amount of variation building up over time, very different forms (new species) are produced.

2. There were fourteen different species of finches on the Galapagos Islands.
3. Their structures are similar to a species of finch found on the mainland.
4. Their beaks were of different shapes and sizes and adapted to eating food in different locations.
5. The original finches came from South America.
6. When there is an accumulation of changes in a population of individuals over time, it becomes unique. The new population, with significantly different characteristics, is a new species.

Section 2: Follow-up Activities

Extra Help

1.
 - a. Organisms produce many offspring.
 - b. The size of a population generally remains the same, generation after generation.
 - c. There is variation among individuals in a population.
 - d. Resources are limited.
2. A population needs food, shelter, and the opportunity to reproduce.
3. There are more individuals than the environment can support. Resources are limited.
4. Those that survive are more successful in gaining the resources necessary for survival. They are probably better adapted to the environment.
5. Because they live longer they produce offspring for a greater duration. They may also be healthier and so would be more productive.
6. Traits that make parents successful are passed on to the next generation.
7.
 - Textbook question a: The first melanic or dark moths were a natural mutation. Some dark moths are born in any population.
 - Textbook question b: The selecting agent is insect-eating birds.
 - Textbook question c: The moths that were not recaptured were eaten by birds.
 - Textbook question d: In the non-polluted sites more normal moths were recaptured. The melanic moths were eaten by birds. In the polluted sites more melanic moths were recaptured. Normal moths were selected and eaten by birds.
 - Textbook question e: In general the environment selects which moth will survive and reproduce and which moth will be eaten.

- Textbook question f: Today pollution has darkened many tree trunks and buildings giving the dark moths more chances to hide from predators. The white moths are at a disadvantage. Since more dark moths survive and reproduce they are more abundant. Natural selection once favoured the light-coloured moths but now favours dark moths.

8. d Populations outgrow their environment's capacity to support them.
- b He first proposed that population characteristics change.
- a Organisms with the same physical structures are related.
- e Nature selects which traits will survive in a population.
- c An organ or structure that is well used will improve and be passed to the next generation.

Enrichment

- a. The prime weakness in Darwin's theory was the inability to explain how characteristics were transferred.
 - b. It would be blended out as the individual breeds with others without that trait.
 - c. When round-seeded pea plants were crossed with wrinkled peas, all the offspring bore rounded seeds.
 - d. Units of heredity are not blended, but rather preserved.
 - e. The ratio remains the same.
 - f. Natural selection is the force at work.
 - g. A mutation or sexual recombination could result in a "wondrous monster."
- a. Microevolution is evolution where genera, families, and classes of related organisms evolve from a single ancestral species.
 - b. The fossil record is incomplete.
 - c. Species undergo long stable periods in which there is little change – these are followed by periods of abrupt change.
 - d. Periods of abrupt change coincide with major geological changes.
 - e. Examples of "explosions" of population include multicellular marine organisms at the beginning of the Cambrian period, dinosaurs at the beginning of the Triassic period, and mammals after the extinction of dinosaurs.
 - f. The existence of species-rich populations and the diversity of species both support punctuated equilibrium.

3. This video is one of the Cosmos series from television. Notice the evolution and natural selection are described as active processes in the universe. Now, think about this for a moment. If this is true, is evolution still occurring? The video has a very surprising ending as it describes possible evolution and natural selection on other planets. While this may be unlikely in this solar system, there is no reason why evolution should be unique to Earth. If, or wherever, life exists elsewhere in the universe, evolution probably occurs. Can you see any evidence of these processes in programs like *Star Wars* or *Star Trek*?
4. The Tyrrell Museum is world-famous and can be visited year round.

NOTES

NOTES



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Biology 20

Student Module Booklet
Module 4

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